I. *Part of a Letter from Mr* Anthony van Leuwenhoek, *concerning Worms obſerv'd in Sheeps Livers and Paſture Grounds.* Delf, Nov. 3. 1703.

THis ſerves to communicate to you my ſlender Obſervations concerning the *Animalcula* that are almoſt always found in Waters, and alſo ſometimes upon Land.

In the Summer of the Year 1702. we had not Rain enough to cover even the loweſt parts of the Meadows adjacent to our City; inſomuch, that none of the Sheep of that year drank of the Waters that uſed to ſtagnate on the ſaid Meadows, which when it happens (according to the opinion of our Butchers) produces a certain ſort of Worms called *Bottiens* in their Livers, whereof we have formerly ſpoken more than once. Notwithſtanding which, I was informed that ſome of the Sheep of thoſe Paſtures had their Livers infected with ſuch like Worms; this made me conjecture that the above-mentioned Diſtemper in the Livers of the Sheep muſt proceed from ſome other cauſe than their drinking the ſaid Waters.

I cauſed a Butcher therefore, who was Owner of one of theſe Meadows (and who had alſo informed me that the Sheep which he turned into that Ground were mightily peſter'd with Worms in their Livers) to cut me two pieces of Greenſod from thence, to the end I might try whether I could find any ſuch Worms in them.

This Land he told me was ſo high, that it was never wholly under Water in Winter time, but the Ditches about it were ſo full, that they were in a manner level with the Land, and ſome of the lowermoſt parts of the ſame,

The Royal Society is collaborating with JSTOR to digitize, preserve, and extend access to
Philosophical Transactions (1683-1775).
www.jstor.org

ſame, when it rained much, were a ſhort time covered.

I narrowly ſifted thoſe two pieces of the Earth, but could find no *Animalcula* in them that any way reſembl'd the Worms in the Sheeps Livers.

From hence I infer, that the *Animalcula* that are found not only in Sheeps but in Cows Livers too, muſt not be ſought for in thoſe Waters that ſtagnate upon the Land, (as I formerly thought, and the Butchers alſo are of the ſame opinion) but that we muſt ſeek them in the Land it ſelf; which being throughly wet or ſoaked, they aſcend to the ſuperficies of it, becauſe the common Water being not natural to them, they cannot live in it; and thus lurking in the Graſs they are ſwallowed by the Cows and Sheep, and ſuch as eſcape their Teeth are conveyed into their Stomachs and Bowels, and inſinuate themſelves even into the Liver.

I have been often told that the Cattel which feeds in *Siltagtig* Grounds are free from this Diſeaſe of Worms, but being informed that the ſaid kind of Ground is very low, and lies under Water the moſt part of the Winter, I gave the Butcher theſe Reaſons:

Why Kine and Sheep that feed in high Clay grounds are troubled with Worms in their Livers, and thoſe in low Grounds are free, is, only becauſe the low Grounds lie all the Winter under Water; for tho ſuch like Worms may be found in ſome of the low Lands, yet as ſoon as they are overwhelm'd with Water, thoſe Worms, abhorring the Water, die immediately.

To confirm my reaſoning, I took a Glaſs Tube, which at the upper end was about an Inch wide, and above a Foot in length, I put into it a little piece of the abovementioned Earth near 5 Inches long, but ſo narrow, and the Graſs about it clipt ſo cloſe, that it would eaſily go into the Tube without preſſing, and then poured upon it boil'd Water, which had ſtood till it was cold.

Preſently after I perceiv'd that ſeveral very ſmall and

long

long white Worms came out of the Earth, which reaching and incurvating their bodies, ſubſided leiſurely to the bottom of the Tube, none of them being able to emerge to the ſuperficies, whence I concluded that they could not live in the Water; and in effect, after they had lain 24 hours in the bottom of the Glaſs, I found they were all dead.

It ſeem'd to me alſo that theſe white Worms conſiſted of ſeveral ſizes or magnitudes, and that they could not be the Offſpring of our common Worms, becauſe they were much longer, in proportion to their bigneſs.

I ſaw likewiſe a common Worm creeping out of the aboveſaid Earth, which leiſurely ſubſided and remained at the bottom of the Tube with little or no motion, and the next day it was dead.

As for thoſe ſmall *Animalcula* that came out of the Earth, and ſwam about the Water, they were of ſo many ſeveral ſorts and ſizes, that the deſcription of them would take up too much room, beſides ſome of theſe *Animalcula* were ſo exceeding ſmall, that I could not perceive what figure they were of, tho I viewed them very nicely and very frequently, nay, tho I ſhifted the Earth and Water three times.

Now that theſe *Animalcula* may be call'd Water-worms, tho they are found in the dryeſt part of the Earth, appears from their living ſo well in the Tube filled with Water, in which, tho I obſerv'd them day after day, I found no difference in them, ſave that they were encreaſt in number, and beſides I have met with ſeveral of them in common Water.

In theſe Obſervations I diſcovered a few particles of Sand mixt with Clay, the ſides of which appear'd as if they had been broken or grated off from Stones, and ſome of them were ſo very ſmall, that above a thouſand of them together did not exceed the magnitude of a ſingle grain of common Sand that is us'd in Scowring, &c.

I went another time into one of the Meadows near our Town, it conſiſted of a good Clay Earth, and was as high as any of thoſe about us; I dug out a little bit of the ſaid Earth, about the bigneſs of a Crown piece, which was covered with Clover-graſs, ſhort and fine; I imagined I ſhould find in the top of it ſome living Creatures, becauſe I had formerly found in the rotten wood of a Willow Tree, and in another rotten Plank that had lain in the open Air, ſome of thoſe *Animalcula* which are uſually found in the Water.

When I came home I clipt away the Graſs from the Earth or Clay, and put the top of it in a clean Glaſs Tube about as big as a Childs Finger, and pour'd upon it boil'd Rain Water after it was cold, and having ſhaken that Earth and Water well together, the Water was ſo thick and troubl'd, that I could perceive none of the *Animalcula* therein, tho there were a great many in it.

But after the ſaid Water had ſtood about half an hour in the Tube, I could perceive ſeveral *Animalcula* creeping up the ſides of it, and others ſwimming about the Water.

This Water having ſtood ſeveral hours, and acquired a little more clearneſs, I ſaw two particular *Animalcula* that came very near in Figure to thoſe that produce *little Wheels* out of their Bodies, only inſtead of ſuch *Wheels* they protruded a Horny part out of their Body, which they ſometimes drew in, and then thruſt out again; there was alſo one *Animalculum* that put out *two Wheels*, and juſt by I perceived two other ſorts of *Animalcula*, but immediately loſt ſight of them again; from whence I concluded, that ſo much Water was not natural to them, and therefore they were dead; and after that the Water had ſtood three days upon the Clay, I ſaw ſeveral *Animalcula* that were four times as long and as thick clinging to the ſides of the Glaſs without any motion, tho they ſtirred about briſkly at the firſt.

I took another Glaſs Tube, and put into it a little of the ſame Earth which I handled very tenderly, pouring upon it ſome of the boiled Water as before without ſhaking it at all, that the *Animalcula* might emerge the better, and after an hours time I ſaw above twenty *Animalcula* ſwimming, whereas in the firſt I could perceive none; and one of them thruſt Wheels out of his Body.

Now it will appear ſtrange to ſome, that theſe *Animalcula*, which uſually and naturally ſwim in the Water, ſhould be found in Earth that has not been moiſten'd by Rain or otherwiſe in ſeveral weeks; but they muſt be informed, as I have often found by experience, that ſeveral ſorts of very ſmall *Animalcula* are to be met with in Rain water, and eſpecially in the Gutters on the tops of Houſes; for I have taken ſome of the ſlime or dirt of thoſe Gutters after they have been dry above a year, and diluted the ſame in boiled Water after it was cold, whereupon I ſaw ſeveral *Animalcula* ſwimming, and ſome of them being up folded almoſt in a Globular Figure, extended theit Body leiſurely, and then ſwam about the Water.

If it be objected, how comes it to paſs that theſe *Animalcula* that are meerly aquatil ſhould be found on the Land ſeveral rods diſtant from any Ditch; I anſwer, I conceive this to happen after the following manner.

We have often found in a Storm, that the Water has been ſo furiouſly driven againſt the ſides of the Ditches, and the parts of ſuch Water ſo minutely divided, that not only ſeveral of its ſmaller Particles have been carried a great way into the Land by the ſtrong Wind, but ſome of them alſo thruſt up, or attracted even into the Clouds; and I am confirmed in this opinion by the following inſtance: I ſtood one time to obſerve with what force, and how great a diſtance a Bleecher caſt Water with his Scoop out of a Ditch upon his Linnen that was ſpread over the Meadow, whereby many of the parts of the Water

were

were ſo divided, that they never fell to the Earth, but were exhaled up into the Clouds.

In the ſaid ſmall Particles of Water are conveyed the above-mentioned ſmall *Animalcula* far up into the Land, and when the Ground becomes dry, they contract themſelves into an oval Figure, and the Pores of their Skin are ſo well clos'd, that they do not perſpire at all, whereby they preſerve themſelves till it Rains, upon which they open their Bodies and enjoy the moiſture. And thus, in my poor opinion, it happens that we find theſe *Animalcula* in every Meadow of our Country, none of which are very remote from the Sea or Water Canals.

II. Solutio Problematis.

A Clariſſ. viro D. Jo. Bernoulli in Diario Gallico Febr. 1403. *Propoſiti.*

Quam D. G. Cheynæo communicavit Jo. Craig.

P*Roblema.* Propoſitæ Curvæ Geometricæ alias innumeras Longitudine Æquales invenire.

Solutio. Sint w, s, co-ordinatæ Curvæ datæ; & Curvæ quæſitæ ſint co-ordinatæ x, y: tum ex conditione Problematis erit $dw^2 + ds^2 = dx^2 + dy^2$. Ponatur $dx = dw - m\,dz$, unde erit $dy = \sqrt{ds^2 + 2m\,dw\,dz - m^2\,dz^2}$; in hac pro ds ſubſtituatur ejus valor per w, dw & determinatas expreſſus: & pro dz aſſumatur talis valor ex w, dw & determinatis compoſitus, ut valores quantitatum dx, dy ſint ſummabiles: Et ſic habentur x ac y Co-ordinatæ Curvæ quæſitæ. Q. E. J.

Exemplum 1. Invenire Curvam æqualem Lineæ Parabolicæ. Sit $2a$ latus rectum Parabolæ; adeoq; $2as$